Population and Economic Projections for the State of Hawaii to 2035

DBEDT 2035 Series

Research and Economic Analysis Division
Department of Business, Economic Development and Tourism
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I. Summary of Projections

This report presents the results and methodology of the 2035 Series of the DBEDT's Population and Economic Projections for the State of Hawaii and its four counties.

The DBEDT's 2035 projection series were produced using the Hawaii Population and Economic Projection and Simulation Model, which was developed by the Department in 1978 and refined over the years. It is an inter-industry econometric model that generates economic and demographic forecasts for the state and its four counties on an annual basis. The DBEDT's 2035 series uses the 2020 methodology with some modification to incorporate the inter-county input-output (I-O) table into the model.[1] The 2035 Series uses the 2007 population estimates, detailed characteristics of county population from the 2000 Population Census, 2005 estimates of economic variables, and updated input-output (I-O) tables based on the 2002 Economic Census as baseline data for the projection.

It should be noted that these projections are neither targets nor goals. They are DBEDT's best estimates of likely trends in important population and economic variables based on currently available information. The accuracy of these projections depends on the degree to which historical trends provide guides to the future, changing external conditions, infrastructure capacity, and other supply constraints which have not been incorporated into the model.

1. Population

The resident population of Hawaii, which includes active-duty military personnel and their dependents, is projected to increase from 1,275,200 in 2005 to 1,685,200 in 2035, an average rate of growth of 1.0 percent per year over the projection period.

The population of active-duty military personnel is assumed to gradually increase from 43,700 in 2005 to 46,700 in 2015 and remain constant thereafter. The size of military dependents relative to active-duty military personnel and its age and sex composition is assumed constant at the level in the 2000 Population Census.

Table 1-1 presents the projection of total resident population by county. As has been the case in previous DBEDT's long-range projections, the Neighbor Island counties are projected to have higher population growth than Honolulu. The resident population of the City and County of Honolulu is projected to increase at an annual rate of about 0.7 percent from 2005 to 2035, while Hawaii County is projected to grow at about 1.8 percent annually, Maui County at 1.3 percent, and Kauai County at 1.1 percent.

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[1] Conway, R.S., *Hawaii Projection and Simulation Model*, June 1995.
Population and Economic Projections for the State of Hawaii to 2020: Report of Results and Methodology, Research and Economic Analysis Division, DBEDT, May 1997.

As a result, the combined share of the Neighbor Island counties in state total population will increase from 28.8 percent in 2005 to 33.9 percent in 2035, while the corresponding share of the Honolulu County is projected to decrease from 71.2 percent to 66.1 percent.

Table 1-1. Resident Population by County: 1980-2035*

Year	State Total	Hawaii County	Honolulu County	Kauai County	Maui County
1980[1/]	968,500	92,900	764,600	39,400	71,600
1985[1/]	1,039,700	105,900	804,300	44,400	85,200
1990[1/]	1,113,500	121,600	838,500	51,700	101,700
1995[1/]	1,196,900	140,500	881,400	57,100	117,900
2000[1/]	1,211,600	149,100	875,100	58,500	128,900
2005[1/]	1,267,600	164,800	902,000	61,700	139,100
2010[2/]	1,332,900	185,800	932,100	65,300	149,600
2015[2/]	1,410,700	205,800	973,700	69,400	161,700
2020[2/]	1,482,400	225,000	1,010,400	73,500	173,500
2025[2/]	1,552,000	243,400	1,046,000	77,500	185,100
2030[2/]	1,619,900	261,300	1,080,700	81,400	196,500
2035[2/]	1,685,200	279,200	1,113,300	85,100	207,600
Average annual growth rate (%)					
1980-1985	1.5	2.8	1.1	2.6	3.7
1985-1990	1.3	2.6	0.8	2.9	3.4
1990-1995	1.6	3.2	1.1	2.2	3.2
1995-2000	0.2	1.1	-0.1	0.5	1.7
2000-2005	1.0	2.4	0.7	1.4	1.8
2005-2010	1.0	2.4	0.7	1.2	1.5
2010-2015	1.1	2.1	0.9	1.2	1.6
2015-2020	1.0	1.8	0.7	1.2	1.4
2020-2025	0.9	1.6	0.7	1.1	1.3
2025-2030	0.9	1.4	0.7	1.0	1.2
2030-2035	0.8	1.3	0.6	0.9	1.1

[1/] Source: Population Division, U.S. Census Bureau. The 2005 population figures for counties are DBEDT's estimates.
[2/] Forecasts by the DBEDT.
* Figures presented here can be different from those in the appendix tables because of rounding.

The size and composition of the population are affected by the interaction of three variables: births, deaths, and net migration. This projection is based on the assumption that the fertility rate will remain constant at the 2005 level, while survival rate is assumed to steadily improve over the projection period. The methodology used to calculate the future value of survival rates is discussed in the next section in detail.

Due to population aging and larger increases in deaths than births, natural population increase (i.e., total births minus total deaths) will decrease over time even with improving survivorship (Table 1-2). This implies that the state will need more net-migration than experienced in the past to support the same level of population growth. Migration is the variable that has shown the greatest volatility in the past. Since a large portion of migration is determined by non-economic factors, it is difficult to project future level of migration with accuracy using an economic forecasting model. However, with a slower economic growth projected for the later period of the projection it is likely that the level of net-migration will also steadily decrease over time.

For the projections, domestic migration is assumed to depend on the statewide unemployment rate. The statewide average annual domestic net migration during 2005-2035 is projected to be 3,200. International net migration is assumed to remain at the average level of international net migration observed in the past 5 years, which is 5,340 per year.

Table 1-2. Components of Change in the Civilian Population: 1980-2035*

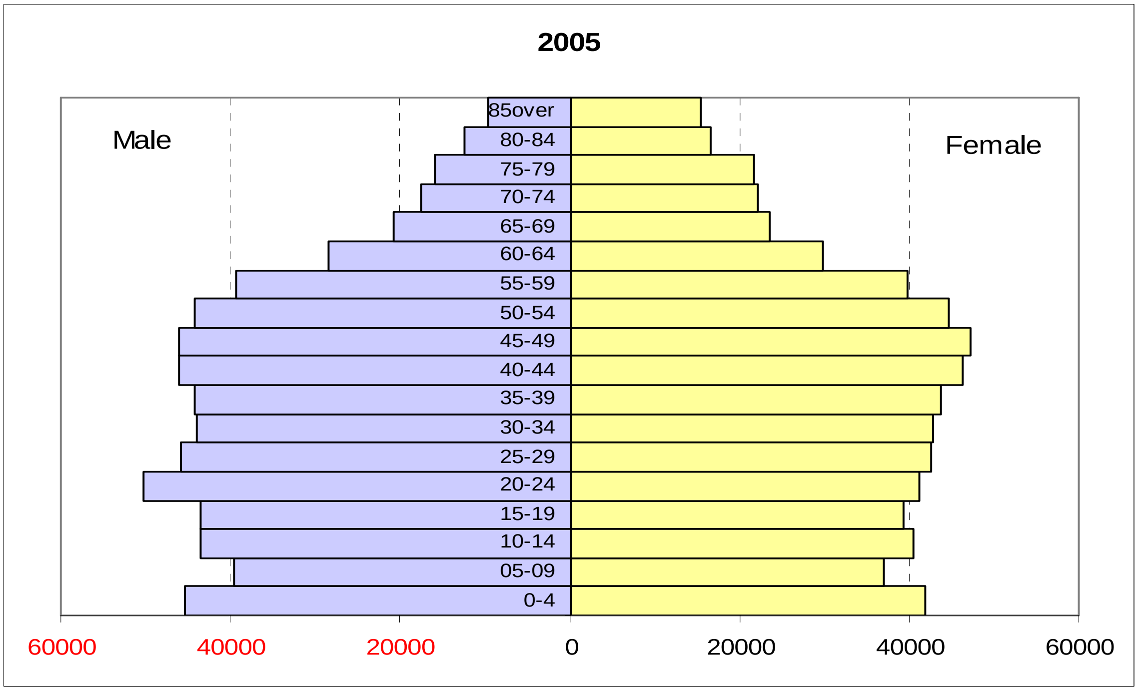
(Annual average for the period)

Period	Population change	Number of births	Number of deaths	Net migration
1980-1985[1/]	14,700	14,700	5,200	5,200
1985-1990[1/]	15,700	15,000	6,100	6,800
1990-1995[1/]	20,500	16,000	7,000	11,500
1995-2000[1/]	5,500	14,700	8,000	-1,300
2000-2005[1/]	12,576	14,600	8,400	6,400
2005-2010[2/]	11,300	15,400	9,300	5,000
2010-2015[2/]	14,900	16,100	10,000	8,800
2015-2020[2/]	14,300	16,800	10,900	8,500
2020-2025[2/]	14,000	17,400	11,700	8,300
2025-2030[2/]	13,600	17,900	12,500	8,200
2030-2035[2/]	13,100	18,500	13,600	8,200

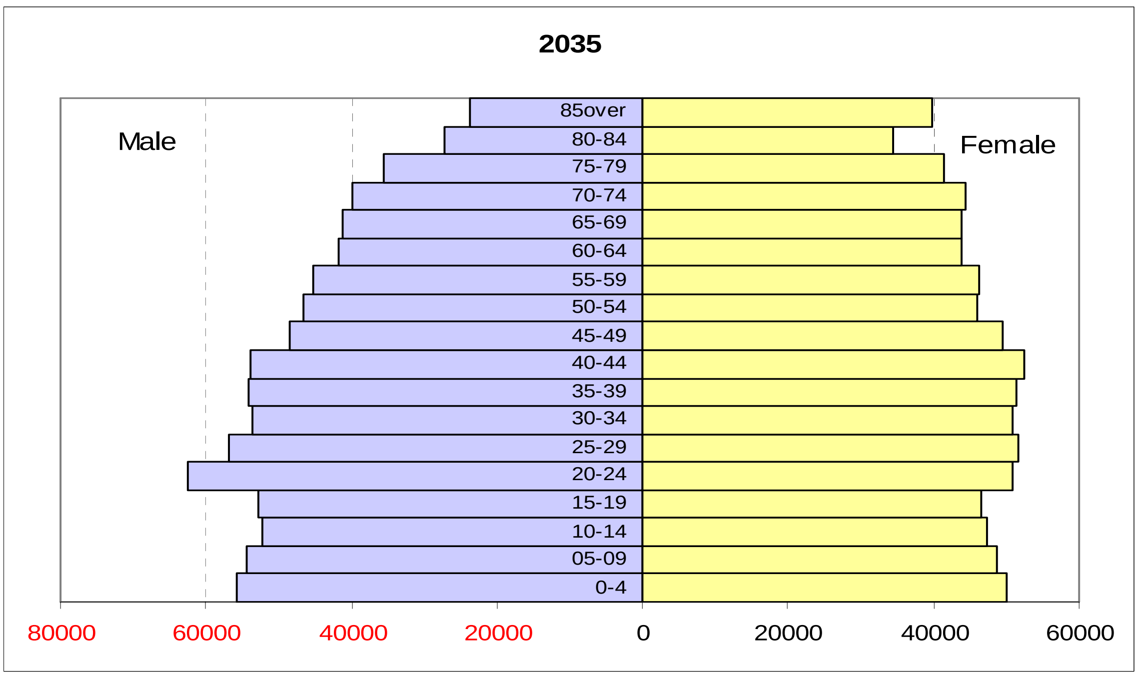
1/ Source: Population Division, U.S. Census Bureau.
2/ Forecasts by the DBEDT.
* Figures presented here can be different from those in the appendix tables because of rounding.

Aging of the population has been one of the most prominent features of Hawaii population trends. The share of the population aged 65 years and over of the total population increased from 8.0 percent in 1980 to 13.8 percent in 2005. This trend will continue in the future, increasing this share of the total population to 22.0 percent in 2035. Figures 1-1 compares the age structure of the population of the State of Hawaii in 2005 and 2035 by gender. As seen in the figure, the aging of Hawaii's population is more evident for the female population.

Figure 1-1. Age Distribution for the Resident Population of Hawaii: 2005 and 2035



Source: Population Division, U.S. Census Bureau.



Source: DBEDT Projections.

Projections of population for the state and four counties by selected characteristics and by five-year age group are presented in Appendix Tables A-2 through A-15.

2. Gross Domestic Product (GDP) and Final Demand

Projections of key economic and demographic variables are summarized in Tables 1-3 and 1-4. The projection predicts a moderate economic growth as a whole. The real gross domestic product (GDP) of Hawaii is forecast to grow at 1.9 percent per year over the projection period.

Table 1-3. Projection of Selected State and County Variables: 2005-2035*

	2005 1/	2010	2015	2020	2025	2030	2035
State							
GDP (mil. 2000$)	46,920	53,290	58,570	63,580	69,260	75,440	82,200
Population	1,267,600	1,332,900	1,410,700	1,482,400	1,552,000	1,619,900	1,685,200
Civilian wage & salary jobs	638,400	681,300	726,200	763,000	802,700	842,800	883,400
Total civilian jobs	791,600	858,700	920,400	972,100	1,028,000	1,084,700	1,142,600
Labor force	631,300	679,500	721,000	754,900	790,000	825,100	859,800
Total civilian employment	614,300	654,800	691,300	721,400	753,600	785,800	818,400
Personal income (mil. 2000$)	39,140	43,370	47,630	51,760	56,390	61,420	66,880
Honolulu County							
Population	902,000	932,100	973,700	1,010,400	1,046,000	1,080,700	1,113,300
Civilian wage & salary jobs	465,200	493,900	524,000	547,600	573,700	600,200	627,400
Total civilian jobs	560,900	603,900	643,700	675,600	710,800	746,700	783,800
Personal income (mil. 2000$)	29,700	32,650	35,650	38,520	41,740	45,250	49,080
Hawaii County							
Population	164,800	185,800	205,800	225,000	243,400	261,300	279,200
Civilian wage & salary jobs	68,800	75,400	82,000	88,000	94,400	101,000	107,600
Total civilian jobs	92,400	103,400	113,100	122,000	131,700	141,600	151,800
Personal income (mil. 2000$)	3,950	4,530	5,110	5,700	6,370	7,110	7,911
Kauai County							
Population	61,700	65,300	69,400	73,500	77,500	81,400	85,100
Civilian wage & salary Jobs	31,300	33,300	35,700	37,700	39,800	41,900	43,900
Total civilian jobs	41,900	45,400	49,000	52,200	55,400	58,700	61,900
Personal income (mil. 2000$)	1,620	1,780	1,970	2,160	2,360	2,580	2,820
Maui County							
Population	139,100	149,600	161,700	173,500	185,100	196,500	207,600
Civilian wage & salary jobs	73,200	78,700	84,600	89,700	94,800	99,800	104,500
Total civilian jobs	96,500	106,000	114,600	122,300	130,100	137,700	145,100
Personal income (mil. 2000$)	3,880	4,400	4,900	5,380	5,910	6,480	7,070

1/. Actual Figures, Source: Population-U.S. Census Bureau; GDP, jobs, and personal income-U.S. Bureau of Economic Analysis (BEA); Labor force, and employment-Hawaii Department Labor and Industrial Division (DLIR)
* Figures presented here can be different from those in the appendix tables because of rounding.

The growth of GDP depends on demand from outside the region as well as local consumption and investment. Demand from outside the region is assumed exogenously as it is determined by factors that are difficult to incorporate in the model.

Historically, personal consumption in Hawaii has shown an income elasticity of a little over one. Assuming similar consumption behavior for the future, personal consumption expenditures (PCEs) are projected to grow at 2.2 percent annually in real terms over the projection period. Government consumption expenditures, that have shown a much faster growth than that of PCEs in the past, for both the federal and the local government, are projected to grow at about same rate as PCE.

Table 1-4. Average Annual Growth Rates for Selected Variables: 2005-2035 (%)

	2005-2010	2010-2015	2015-2020	2020-2025	2025-2030	2030-2035
State						
GDP	2.6	1.9	1.7	1.7	1.7	1.7
Population	1.0	1.1	1.0	0.9	0.9	0.8
Civilian wage and salary jobs	1.3	1.3	1.0	1.0	1.0	1.0
Total civilian jobs	1.6	1.4	1.1	1.1	1.1	1.1
Labor force	1.4	1.2	0.9	0.9	0.9	0.8
Total civilian employment	1.3	1.1	0.9	0.9	0.8	0.8
Personal income	2.1	1.9	1.7	1.7	1.7	1.7
Honolulu County						
Population	0.7	0.9	0.7	0.7	0.7	0.6
Civilian wage and salary jobs	1.2	1.2	0.9	0.9	0.9	0.9
Total civilian job	1.5	1.3	1.0	1.0	1.0	1.0
Personal income	1.9	1.8	1.6	1.6	1.6	1.6
Hawaii County						
Population	2.4	2.1	1.8	1.6	1.4	1.3
Civilian wage and salary jobs	1.9	1.7	1.4	1.4	1.4	1.3
Total civilian jobs	2.3	1.8	1.5	1.5	1.5	1.4
Personal income	2.8	2.4	2.2	2.3	2.2	2.2
Kauai County						
Population	1.2	1.2	1.2	1.1	1.0	0.9
Civilian wage and salary jobs	1.3	1.4	1.1	1.1	1.0	0.9
Total civilian jobs	1.6	1.5	1.3	1.2	1.2	1.1
Personal income	2.0	2.0	1.8	1.9	1.8	1.8
Maui County						
Population	1.5	1.6	1.4	1.3	1.2	1.1
Civilian wage and salary jobs	1.5	1.4	1.2	1.1	1.0	0.9
Total civilian jobs	1.9	1.6	1.3	1.2	1.1	1.1
Personal income	2.6	2.2	1.9	1.9	1.8	1.8

This projection accounts for large government construction plans that have already been approved and scheduled for the projection period. Besides these, the projection anticipates an overall slowdown in the long-term growth of investment, leading to a forecast of a moderate GDP growth.

Another factor that contributes to the moderate level of GDP growth is an anticipation of a slow tourism growth. Tourism expenditures are expected to grow at an average of 0.9 percent annually in real terms. Table A-66 in Appendix provides more detailed tourism projections by county.

3. Personal Income

As presented in Table 1-4, Hawaii's total personal income is forecast to grow at an annual rate of 1.8 percent in real terms over the projection period. Among the components of personal income, transfer payments are expected to grow at a faster rate than other components because of increased retirement incomes of the aging population. As a result, the share of transfer payments of total personal income is projected to increase from 12.8 percent in 2005 to 18.5 percent in 2035, while the share of labor income, the largest component of personal income, is projected to decrease from 80.4 percent in 2005 to 76.8 percent in 2035 (Table 1-5).

With a growing population, per capita personal income will grow at a lower rate than that of total personal income. Hawaii and Maui Counties, especially, are expected to experience a relatively low growth of per capita personal income as a result of a higher population growth.

Figure 1-2. Average Annual Growth of Real Personal Income for the State

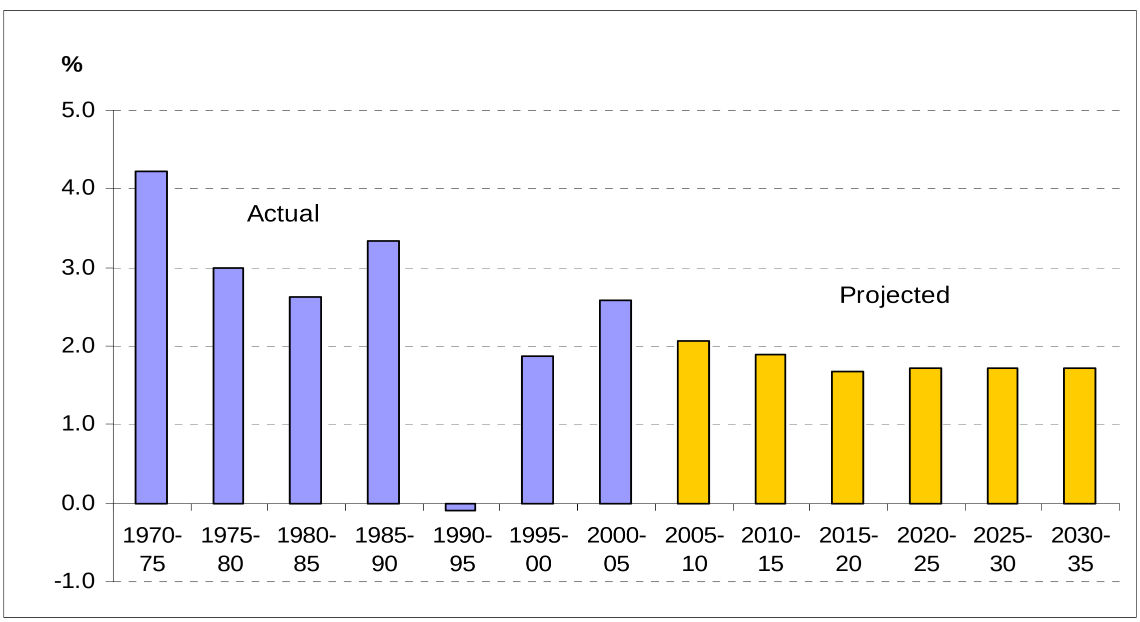


Table 1-5. Components of Total Personal Income

Year	Labor Income		Contributions for Gov't Insurance		Dividends, Interest and Rent		Transfer Payments		Total Personal Income	
	mil. 2000$	share in PI (%)	mil. 2000$	share in PI (%)	mil. 2000$	share in PI (%)	mil. 2000$	share in PI (%)	mil. 2000$	share in PI (%)
2005[1/]	31,490	80.4	3,260	8.3	5,920	15.1	4,990	12.8	39,140	100
2010	34,830	80.3	3,710	8.6	6,520	15.0	5,730	13.2	43,370	100
2015	38,110	80.0	4,180	8.8	7,050	14.8	6,650	14.0	47,630	100
2020	41,090	79.4	4,630	9.0	7,570	14.6	7,740	15.0	51,760	100
2025	44,350	78.7	5,140	9.1	8,130	14.4	9,050	16.1	56,390	100
2030	47,770	77.8	5,680	9.2	8,730	14.2	10,600	17.3	61,420	100
2035	51,370	76.8	6,260	9.4	9,380	14.0	12,390	18.5	66,880	100

1/ Actual Figures, Source: U.S. Bureau of Economic Analysis (BEA).

Detailed historical series and projections of personal income are reported in Appendix Tables A-52 through A-57.

4. Employment

Labor force is determined by the size of the working-age population and the labor force participation rate. The working-age population, consisting of persons 16 years of age and over, is expected to grow faster than the total population. This is mostly attributable to the expansion of the "older" population segment consisting of persons 65 years and over. The growth of the labor force will be slower than the growth of the working-age population as this "older" population leaves the workforce and moves into retirement.

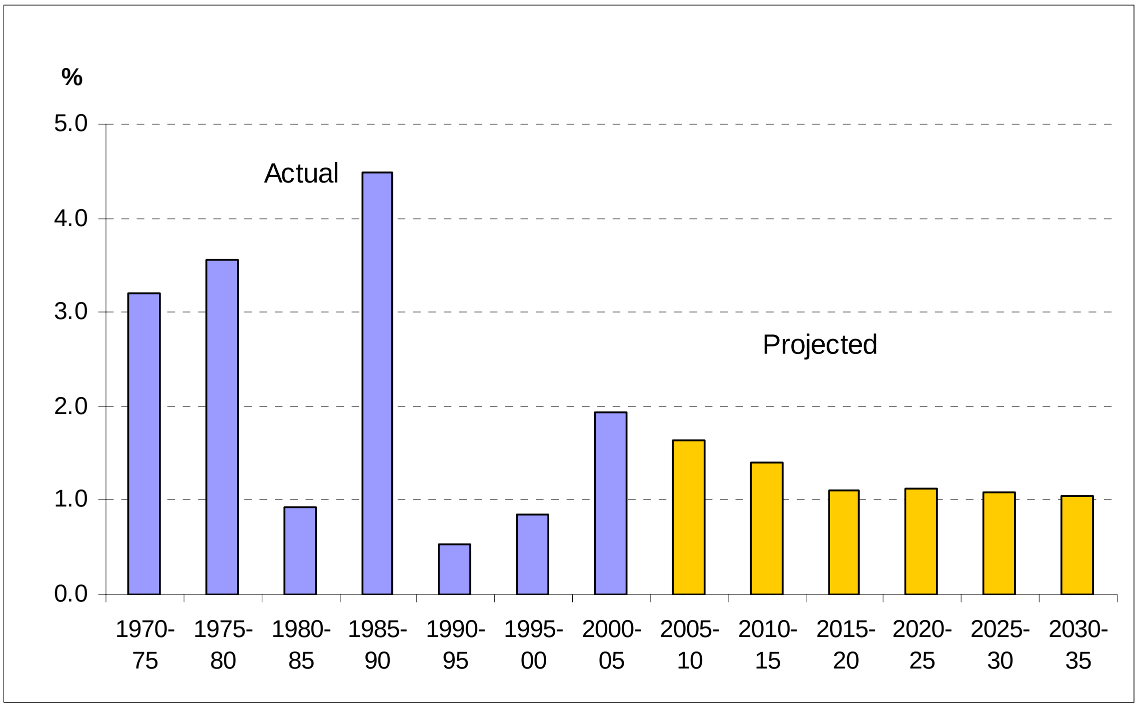
In the short term, the labor force participation rate is affected by current labor market conditions. In the long term, this rate is determined by the composition of the working-age population. The steady increase in the labor force participation rate over the years was mainly caused by the increasing share of women in the labor force. With the labor force participation rate of women stabilized, the long-term labor force participation rate is expected to gradually decrease over time due to the aging of the population.

Total civilian wage and salary jobs in Hawaii are expected to increase from 638,400 in 2005 to 883,400 in 2035, an average annual growth of 1.1 percent during the forecast period. Total civilian jobs (wage and salary jobs plus self-employed jobs) are expected to show a higher growth than that of civilian wage and salary jobs owing to increasing share of self-employed jobs of total jobs. The share of self-employed jobs of total civilian jobs has increased from 14.7 percent in 1980 to 19.4 percent in 2005, reflecting a faster growth in self-employed jobs than wage and salary jobs. This trend is expected to continue in the future, but at a more moderate rate than observed in the past.

Jobs in the other counties have increased at a much faster rate than in Honolulu in the past, and this trend is expected to continue over the projection period. Even though the jobs in the Neighbor Island counties are not expected to grow as fast as their populations, a faster job growth in the Neighbor Islands than the state as a whole will increase their share of statewide total jobs to 31.4 percent in 2035 from 29.1 percent in 2005.

Projections of jobs for the state and counties by sector are presented in Appendix Tables A-42 through A-51.

Figure 1-3. Average Annual Growth of Total Civilian Jobs for the State



5. Impact of Alternative Tourism Growth

In addition to the baseline forecasts presented above, the model also provides forecasts of key variables under alternative scenarios of tourism growth. Table 1-6 summarizes these scenarios of tourism growth. As explained in detail in the methodology section, the baseline scenario is based on the assumption that annual growth rate of visitor arrival is about 1.0 percent between 2005 and 2035, while high and low growth scenarios assume 1.5 percent and 0.4 percent annual growth in visitor arrival, respectively. In interpreting the resulting forecasts based on the alternative scenarios, it needs to be noted that the purpose of providing the alternative forecasts is to show the likely impact of change in tourism demand without validating the likelihood of the alternative tourism growth scenarios.

Table 1-6. Annual Growth Rate of Visitor Expenditure in Real Terms under Alternative Tourism Growth Scenarios (%)

	2006-2010	2010-2015	2015-2020	2020-2025	2025-2030	2030-2035
Baseline Scenario						
State	1.3	1.2	1.1	0.9	0.7	0.6
Hawaii County	1.3	1.5	1.4	1.2	1.0	0.9
Honolulu County	1.5	1.0	0.9	0.7	0.5	0.4
Kauai County	1.1	1.2	1.1	0.9	0.7	0.6
Maui County	1.2	1.4	1.2	1.0	0.8	0.7
High Tourism Growth Scenario						
State	2.0	1.9	1.8	1.5	1.4	1.2
Hawaii County	1.9	2.2	2.1	1.8	1.7	1.5
Honolulu County	2.2	1.7	1.6	1.3	1.2	1.0
Kauai County	1.8	1.9	1.8	1.5	1.4	1.2
Maui County	1.8	2.1	1.9	1.6	1.5	1.3
Low Tourism Growth Scenario						
State	0.7	0.7	0.5	0.2	0.0	-0.1
Hawaii County	0.7	1.0	0.8	0.5	0.3	0.2
Honolulu County	0.9	0.5	0.3	0.0	-0.2	-0.3
Kauai County	0.5	0.7	0.5	0.2	0.0	-0.1
Maui County	0.5	0.9	0.6	0.3	0.1	0.0

Table 1-7 shows that if visitor arrival grows at annual rate of 1.5 percent under the high tourism growth scenario, the annual job growth rate will be about 0.4 percentage point higher and the state would have about 12 percent more jobs in 2035 compared to the baseline forecast based on a 1.0 percent annual growth in visitor arrival. Likewise, if the visitor arrival grows at 0.4 percent annually under the low tourism growth scenario, the statewide projected total jobs in 2035 would be about 10 percent lower than the total jobs projected under the baseline scenario.

The impact of the change in tourism demand on the region's economy will be greater if the region is more dependent on tourism. Compared to Honolulu County, the Neighbor Islands counties have higher dependency on tourism, and hence their economies are projected to be more responsive to the changes in tourism industry. The forecasts of other key variables corresponding to the alternative tourism scenarios are presented in Appendix (Tables A-67 through A-70).

Table 1-7. Total Civilian Jobs in 2035 under Alternative Tourism Growth Scenarios

Baseline Tourism Growth Scenario			
	Average annual rate of total job growth 2005-2035	Total civilian jobs in 2035	
State	1.2%	1,142,600	
Hawaii County	1.7%	151,800	
Honolulu County	1.1%	783,800	
Kauai County	1.3%	61,900	
Maui County	1.4%	145,100	
High Tourism Growth Scenario			
	Average annual rate of total job growth 2005-2035	Total civilian jobs in 2035	Difference from the baseline forecasts
State	1.6%	1,279,500	12.0%
Hawaii County	2.2%	174,700	15.1%
Honolulu County	1.4%	862,300	10.0%
Kauai County	1.8%	71,600	15.7%
Maui County	1.9%	170,800	17.7%
Low Tourism Growth Scenario			
	Average annual rate of total job growth 2005-2035	Total civilian jobs in 2035	Difference from the baseline forecasts
State	0.9%	1,031,800	-9.7%
Hawaii County	1.2%	133,300	-12.2%
Honolulu County	0.8%	719,600	-8.2%
Kauai County	0.9%	54,100	-12.6%
Maui County	0.9%	124,800	-14.0%

II. Hawaii Population and Economic Projection Methodology

The specification of the current version of the model is similar to that used in the 2020 projection series, albeit with some new features. The 2020 projection series used the state input-output (I-O) model to produce the state-level projections. The state-level projections were then allocated to each of the four counties through a county allocation procedure. The main difference of the current projections from the 2020 projection series is that outputs and jobs are estimated at the county level using an inter-county I-O table. The inter-county I-O table was first introduced to the Hawaii long-range projections in its 2030 Series.[2] Using the inter-county I-O table where the flows of goods and services among the four counties are accounted for, it became possible to include interregional linkage and interregional feedback in the model. However, due to lack of data at the county level, a set of regression-based simultaneous equations that had been the main feature of the Hawaii long range projection model were replaced by trend-based projections in the 2030 Series.

In this projection series, we returned to the original formulation of the Hawaii long-range projection model while continuing to use the inter-county I-O tables. To capture county-specific behavior, the variables were estimated at the county level whenever necessary data were available. When data were not available at the county level or when estimations at the county level involved excessive randomness, variables were estimated at the state level and the state-level estimates were then allocated to each county using other relevant information.

As in the 2020 projection series, the model contains five blocks: final demand, income, output, employment, and population. The final demand components were either projected by a set of econometric equations or exogenously given. The statewide projected final demands were allocated to each industry of each county using the relevant final demand vectors in the 2002 inter-county I-O table. Industrial outputs of each county were then derived by multiplying the projected final demands by the total requirements matrix of the 2002 inter-county I-O table. Jobs were derived by dividing each industry's projected output by job-to-output ratio. Once jobs were projected, labor income was estimated as a function of total jobs. Population projection was done separately using the cohort component method, but it was linked with economic module through migration.

For endogenous variables, regression-based analyses were conducted to capture economic relationships among the variables. With a few exceptions, variables were estimated in logarithmic forms so that the estimated coefficients represent elasticities of dependent variables with respect to the change in explanatory variables. When the estimation results showed the presence of autocorrelation in error terms, AR (autoregressive) terms were added to the equations to correct the problem.

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[2] *Population and Economic Projections for the State of Hawaii to 2030: Results and Methodology*, Research and Economic Analysis Division, DBEDT, August 2004.

It must be noted that, despite comprehensive data analysis and the precision of the model calculations, there is no unique solution to the projection of Hawaii's future population and economy. If there is no change in the structure and behavior of the economy over time, analysis of the past would provide an accurate guide to the future. Unfortunately, the future trends in important factors such as fertility, mortality, migration, labor productivity, and labor force participation are inherently uncertain. The future growth of final demand and industrial structure may follow different patterns from the past. Therefore, in addition to analysis of historical economic relationships among variables many subjective judgments on future trends had to be entered to produce the current set of projections.

1. Projection of Final Demand and GDP

Gross Domestic Product (GDP) for states is the state equivalent of GDP for a nation. Two approaches can be used to estimate GDP for a state: the income approach and the expenditure approach. GDP estimates published by the U.S. Bureau of Economic Analysis (BEA) are measured using the income approach as the summation of the factor income earned and costs of production. Here GDP was estimated using the expenditure approach as follows.

$$GDP = C + I + G + (X - M)$$

where C : Personal consumption expenditures (PCEs)
I : Private investment
G : Government spending, including government investment
X : Exports
M : Imports

Conceptually, two approaches should yield the same estimates since they are basically two different methods for measuring the state's overall economic activity. However, due to many practical details involved in calculating nominal and real GDP, the estimates of GDP included in the projections need to be compared to the BEA's estimates of GDP with caution.

Each component of GDP can be divided into many sub-components for an effective estimation. Accordingly, private investment was analyzed in terms of two sub-components: construction investment and other investment. Exports were divided into tourism export and non-tourism exports. Government spending was defined in terms of six components: state and local government consumption, state and local government investment, federal defense consumption, federal defense investment, federal civilian consumption, and federal civilian investment. Due to lack of data at the county level, most components of final demand were projected at the state level.

In all estimation equations presented in this report, subscript 't' indicates year while subscripts 'i' and 'j' indicate industry and county, respectively.

Personal Consumption Expenditures (PCEs)

The annual estimates of PCEs for the State of Hawaii were no longer available after 2000 when DBEDT decided to use BEA's estimates of GDP by State instead of estimating on its own. From then on, PCEs of Hawaii were estimated only once during the construction of the 2002 I-O tables. Historically, however, personal consumption has shown a relatively stable relationship with income. Assuming the continuation of this relationship over time, the PCEs were estimated for each year after 2000 and then adjusted to be consistent with the estimates of PCEs in the 2002 I-O tables.

Following the classical consumption theory, the PCEs were assumed to depend on disposable personal income (DPI) as follows.

$$\ln(PCE)_{t,state} = \beta_0 + \beta_1 \bullet \ln(DPI)_{t,\ state} + AR(1)$$

With no time series data on the PCEs at the county level, personal consumption expenditures were estimated at the state level and then the state total was distributed to the four counties according to each county's share of total state personal income.

Private Investment

Determining the size of the capital stock of an economy, investment is a key element of long-term economic growth. In spite of this, forecasting future levels of investment is not an easy task due to the severe volatility and cyclical behavior it shows. A number of different model specifications were examined using data from many different sources. At the end of numerous econometric exercises, the following specifications were adopted.

Private investment was projected in two parts: private investment in structures (PIC) and other private investment (PIO). PIC was modeled as a function of the demand for houses (DHOUSE), unemployment rate (UNEMPRT), and the previous level of PIC. Unemployment rate was included to account for PIC's sensitivity to short-term fluctuations of the economy. Demand for houses was calculated by dividing total population with average household size for that year. Average household size was assumed to gradually decrease from 2.95 in 2005 to 2.8 in 2035 based on its historical trend.

$$PIC_{t,state} = \beta_0 + \beta_1 \bullet UNEMPRT_{t,state} + \beta_2 \bullet DHOUSE_{t,state} + \beta_3 \bullet PIC_{t-1,state}$$

$$DHOUSE_{t,state} = \frac{POPULATION_{t,state}}{HOUSEHOLD\ SIZE_{t,state}}$$

Similarly, other private investment (PIO) was assumed to depend on personal income (PI), unemployment rate (UNEMPRT), and the previous level of other private investment.

$$PIO_{t,state} = \beta_0 + \beta_1 \bullet UNEMPRT_{t,state} + \beta_2 \bullet PI_{t,state} + \beta_3 \bullet PIO_{t-1,s}$$

Government Spending

The projection of state and local government spending was done in terms of two components: state and local government consumption (SLGC) and state and local government investment (SLGI). SLGC was projected as a function of personal income as follows.

$$\ln(SLGC)_{t,state} = \beta_0 + \beta_1 \bullet \ln(PI)_{t,\ state} + AR(1)$$

On the other hand, state and local government investment, which has been small in size and was often a result of political decisions, was assumed to grow at a fixed rate of 1 percent annually in real terms over the projection period.

Federal government spending was divided into four categories: military consumption, military investment, civilian consumption, and civilian investment. Among those, only federal government civilian consumption was estimated using an econometric model, while exogenously determined growth rates were applied to project other categories. Similar to state and local government spending, federal government civilian consumption (FGCC) was assumed to depend on statewide personal income while all other components of federal government spending were assumed to grow at about 1 percent annually in real terms over the forecast period.

$$\ln(FGCC)_{t,state} = \beta_0 + \beta_1 \bullet \ln(PI)_{t,\ state} + AR(1)$$

Exports

Exports consist of the commodities and services that are sold to people and businesses outside the State of Hawaii. If constraints in local production capacity are not considered, the level of exports would depend solely on factors outside the economy. For this reason, future levels of exports were either exogenously given or projected using a separate model.

Exports consist of tourism exports (visitor expenditures) and non-tourism exports. Forecasts of future visitor expenditures for each county were provided by DBEDT's Tourism Research Branch. A detailed description of the methodology used for the projection of visitor expenditures is presented at the end of this section.

With little information on factors affecting non-tourism exports, they were modeled to be determined by the size of output. That is, exports for each industry were calculated assuming that the proportions of output to be exported in total output will remain constant at the levels in the 2002 I-O table.

Imports

The 2002 I-O tables contain information on proportions of inputs imported from outside the Hawaii economy for each of output producing and final demand sectors in that year. It was assumed that these proportions will remain constant over the projection period. Total imports were then estimated by multiplying the projected outputs and final demands by these import coefficients.

2. Projections of Output

Historical data on industrial outputs in Hawaii are not available on an annual basis. The U.S. Census Bureau publishes output data by industry, but at five-year intervals with a three year lag. The 2002 I-O tables of Hawaii were updated based on the 2002 Economic Census, which was the most recent release of output data by the Census Bureau at the time of the construction of the I-O tables.

The 2002 Hawaii I-O tables are available in two versions of industry aggregations. A detailed table includes 67 industry sectors, while a condensed table has 20 industry sectors. Industry classification in this projection series is consistent with the classification in the condensed version of the 2002 I-O tables. A detailed description of the 2002 Hawaii I-O tables is available on the DBEBT's web site at www.hawaii.gov/dbedt/.

The I-O tables include detailed information on flows of goods and services among the final demand and the producing sectors in the economy. Annual outputs for each industry in a county were projected by applying the final demand-output relationships in the 2002 inter-county I-O tables to the annually-projected final demands. To estimate final demand for an industry in a county, first each component of projected final demands was distributed among industries and counties using the final demand coefficients derived from the I-O table. Total final demand for an industry in a county was then estimated by summing up the individual components. The industry outputs were estimated by county using industries' projected final demands and the total requirement matrix from the 2002 I-O table. These projected outputs, in turn, formed the basis for projecting job counts by industry.

3. Projections of Employment

Employment data need to be used with caution because definition and coverage of variables are different by sources of data. Employment can be defined in two different ways, one is "person-based" and the other is "job-based". In general, employment data that are published with labor force and unemployment data are based on household surveys, and are, therefore, "person-based". In this case, employment is defined as the number of people who are employed in a given period regardless of whether the person is working full-time or part-time. Employment based on "job", on the other hand, is defined as the number of positions, full-time or part-time, in a given period. Most employment data compiled by industry are reported by employers and are “job-based. If a person holds two part-time positions, the person would be counted once in the “person-based” employment data, but twice in the “job-based” employment data. Typically, “job-based” employment exceeds the “person-based” employment because of multiple-job holders.

“Person-based” employment statistics are available from the Current Population Survey (CPS) or from the Local Area Unemployment Statistics (LAUS). The example of “job-based” employment data includes ES202 data from the U.S. Bureau of Labor Statistics (BLS) and employment data from the U.S. Bureau of Economic Analysis (BEA).

In this report, the term “employment” is used to mean “person-based” employment, while the term “job” is used to mean “job-based” employment. The estimates of historical labor force, employment and unemployment rate were obtained from the LAUS data published on the web site of the Hawaii Department of Labor and Industrial Relations (DLIR). Jobs data reported in this projection series are consistent with the BEA job data in definition and coverage with one exception that military jobs were subtracted from the BEA jobs data to calculate civilian jobs.

Jobs projections involved two types of jobs: wage and salary jobs and self-employed jobs. Wage and salary jobs were estimated based on the projected outputs, and self-employed jobs were then estimated based on the projected wage and salary jobs.

Total Job (TJOB) =Wage and Salary Job (WSJOB) + Self-employed Job (SEJOB)

Wage and salary jobs for each industry in a county were estimated by multiplying corresponding outputs with county-and-industry specific wage and salary jobs to output ratios. These ratios were derived from the 2002 inter-county I-O tables and adjusted for productivity change. As a result of productivity increase, more output per job and thus, fewer new jobs are required to increase output by a given amount. Job-to-output ratios were adjusted from their 2002 levels to reflect this advancement in production technology. Using historical data on jobs by industry, annual rate of productivity change for each industry was estimated. Because of unavailability of annual output data, estimates of labor productivity growth were developed using the historical ratios of wage and salary jobs and real GDP. The estimated productivity factors were then further adjusted to reproduce actual job numbers observed in 2005 and 2006.

$$\text{WSJOB}_{t,j,i} = \text{OUTPUT}_{t,j,i} * \left(\frac{\text{WSJOB}}{\text{OUTPUT}}\right)_{t,j,i}$$

$$\left(\frac{\text{WSJOB}}{\text{OUTPUT}}\right)_{t,j,i} = \left(\frac{\text{WSJOB}}{\text{OUTPUT}}\right)_{t-1,j,i} * \text{ Productivity Factor}_j$$

Self-employed jobs were projected using WSJOB forecasts and county-and-industry specific ratios of SEJOB to WSJOB. These ratios were also derived from the 2002 inter-county I-O tables and adjusted to account for the observed trend of increasing share of self-employed jobs. The share of self-employed job of total jobs increased from 14.7 percent in 1980 to 19.4 percent in 2005. This trend was found in all four counties, albeit not to same degree. Observed statewide trends in the relationships between two types of jobs were applied to all counties to adjust the ratios annually.

$$SEJOB_{t,\,j,\,i} = WSJOB_{t,\,j,\,i} * \left(\frac{SEJOB}{WSJOB}\right)_{t,\,j,\,i}$$

$$\left(\frac{SEJOB}{WSJOB}\right)_{t,\,j,\,i} = \left(\frac{SEJOB}{WSJOB}\right)_{t-1,\,j,\,i} * \text{Annual Changing Factor}_{state}$$

After total jobs were estimated as the summation of wage and salary jobs and self-employed jobs, EMPLOYED - the average number of people who are employed full-time or part-time- was estimated as a function of total jobs.

$$EMPLOYED_{t,state} = \beta_0 + \beta_1 \bullet TJOB_{t,\,state} + AR(1)$$

$$UNEMPLOYED_{t,state} = LFORCE_{t,state} - EMPLOYED_{t,state}$$

$$UNEMPRT_{t,state} = \frac{UNEMPLOYED_{t,state}}{LFORCE_{t,state}} \bullet 100$$

Labor force consists of all members of the civilian non-institutionalized population aged 16 and over who have a job or are actively seeking one. It is calculated by multiplying the working population (WORKPOP) - population aged 16 and over – with the labor force participation rate (LFPRT).

$$LFORCE_{t,state} = WORKPOP_{t,state} \bullet LFPRT_{t,state}$$

As discussed in the previous section, labor force participation rates are expected to decline over time as a result of an aging population while they will be swayed by economic conditions in a short run. Overall labor force participation rate for the U.S. peaked at 67.1 percent during the period from 1997 to 2000 and it has gradually declined since 2000. Unlike the national trend, the labor force participation rate in Hawaii peaked at 68.5 percent in 1990 and has declined since then. It is not immediately clear whether the decline of Hawaii's labor force participation rate in the 1990s is mainly a result of high unemployment rates during the period or a result of an aging population. In order to include both short-term and long-term factors, the labor force participation rate was modeled to depend on the unemployment rate and the previous level of labor force participation rate. The specification also included an interaction dummy for the years before 1990 to incorporate the change in the way that the current labor force participation rate depended on its own past value.

$$LFPRT_{t,state} = \beta_0 + \beta_1 \bullet UNEMPRT_{t,state} + \beta_2 \bullet LFPRT_{t-1,state} + \beta_3 \bullet DUM80s \bullet LFPRT_{t-1,\,state}$$

where DUM80s: Dummy variable for the year before 1990

4. Projections of Income

Personal income (PI) was projected in terms of four components: Labor income, transfer payments, property income (dividends, interests and rent), and contributions for government insurance. Each of these components was projected separately for each county as described below, and the following formula produced the projections of personal income.

Personal Income=Labor Income + Transfer Payment + Property Income – Contributions for Government Social Insurance

Labor Income

Labor income (LINC) includes wages and salaries, supplements to wages and salaries, and proprietors' income. It was projected for each county as a function of total jobs in the county.

$$\ln(\text{LINC})_{t,j} = \beta_0 + \beta_1 \bullet \ln(\text{TJOB})_{t,j} + \text{AR}(1)$$

Transfer Payments

Transfer payments (TRANS) include retirement and disability insurance, Medicare and other medical benefits, unemployment insurance and other Federal assistance payments. Among those, retirement and disability insurance accounted for about 40 percent of total transfer payments Hawaii residents received in 2005, while medical benefits accounted for another 40 percent. Therefore transfer income was modeled to depend not only on the size of the population but also on the share of older-age population of total population.

The following equation was used to estimate per capita transfer income as a function of the share of population aged 65 years and over (POP65) of total population, and its own lagged value. Total transfer income was then calculated by multiplying total population with the projected per capita transfer income.

$$\left(\frac{\text{TRANS}}{\text{POPULATION}}\right)_{t,j} = \beta_0 + \beta_1 \bullet \left(\frac{\text{POP65}}{\text{POPULATION}}\right)_{t,j} + \beta_2 \bullet \left(\frac{\text{TRANS}}{\text{POPULATION}}\right)_{t-1,j}$$

Property Income

Property income (DIR) includes dividend income, personal interest income, and rent income. The property income accounted for 15.1 percent of total Hawaii personal income in 2005. Many factors, such as interest rate, stock price, and housing price, will affect the future size of the property income. Due to the large uncertainty involved with these variables, however, property income of each county was estimated simply as a function of personal income.

$$\ln(DIR)_{t,j} = \beta_0 + \beta_1 \bullet \ln(PI)_{t,j} + AR(1)$$

Contributions for Government Social Insurance

Contributions for government social insurance (CGI) consist of employer contributions for government social insurance and employee and self-employed contributions for government social insurance. It was estimated as a function of labor income.

$$\ln(CGI)_{t,j} = \beta_0 + \beta_1 \bullet \ln(LINC)_{t,j}$$

Disposable Income

Subtracting personal tax from the projected personal income gives disposable income.

Disposable Income=Personal Income – Personal Tax

Personal tax depends on net personal income after subtracting transfer payments. Since total personal tax is more or less determined as a proportion of aggregated income, tax was estimated in raw value rather than in logarithm. In this way, personal tax will grow about at a same rate as personal income.

$$PTAX_{t,j} = \beta_0 + \beta_1 \bullet (PI_{t,j} - TRANS_{t,j}) + AR(1)$$

5. Projections of Population

The resident population is divided into three components: military personnel, military dependents, and other civilians. The number of military personnel and their dependents stationed in Hawaii is mainly the result of national defense considerations, with the state's economic situation having little impact. In the current projections, the population of active-duty military personnel was assumed exogenously using information available at the time of projection. The size of military dependent population was determined by the total of active-duty military personnel. The ratio of total military dependents to total active-duty military personnel in 2000, 1.15, was used to determine the size of total military dependent population for the projection period. The projected total population of military dependents was then allocated to each age and sex category using the age and sex composition of military dependents in the 2000 Population Census.

The other civilian population was projected from a base population using the cohort-component method. Other civilian population at a year t was estimated as the sum of the survived population from the previous year, births and net migration.

$$CIVILIAN_{t,k}=CIVILIAN_{t-1,k-1}+BIRTHS_t-DEATHS_{t,k}+NETMIG_{t,k}$$

where $CIVILIAN_{t,k}$: number of other civilians at age k in year t
$BIRTHS_t$: number of newborn babies in year t
$DEATHS_{t,k}$: number of other civilians deceased at age k in year t
$NETMIG_{t,k}$: number of migrants at age k in year t

The foundation data sets used for population projections include the annual population estimates for each county by the U.S. Census Bureau, and birth and death data collected by the Office of Health Status Monitoring (OHSM) of the Hawaii Department of Health. At the county level, the U.S. Census Bureau provides only an abridged population table containing data by 5-year age intervals for residents. In order to produce a single age-sex population table for the other civilian population for each county, the single-year age by sex tables for each county and state from the 2000 Population Census were used as supplementary information.

Projection of the population is based on a complex set of assumptions about fertility and mortality. These assumptions play a key role in determining the size of natural population increase and age structure of the population in the future. Methodologies used in estimating current levels of fertility and mortality rates and assumptions about their future levels are explained in detail below.

Fertility Rates

An age-specific fertility rate indicates the probability that a woman of childbearing age will give birth in a given year. Multiplied by the number of females of childbearing age, fertility rates estimate the number of births that will take place in a given year.

The age-and sex-specific fertility rates for each of the four counties were estimated using a birth data from the Hawaii State Department of Health. These data contain detailed information on each individual birth compiled by the sex of baby, the age of mother, the residence and military status of the baby's parents. Since the size of military dependent population is assumed to be determined by the number of the armed forces stationed in Hawaii, births by military dependent female or female in the armed forces were removed from the calculation. The age-and sex-specific fertility rates for other civilian population were then calculated by dividing the number of other civilian births for each gender by the number of other civilian women in each age category. In order to mitigate random fluctuation in estimates due to small sample size, data for three years from 2004 to 2006 were averaged to produce the 2005 estimates of age-specific fertility rates for each county (Appendix Tables A-22 through A-26).

The next step was to adjust the calculated 2005 fertility rates for the likely change in the future fertility rates. Fertility changes over time as a result of changes in population composition, maternity patterns, or as a result of economic and cultural changes. To begin with, the assumptions used in population projections by the U.S. Census Bureau were reviewed. Assumption for future fertility rates used by the U.S. Census Bureau is quite confusing as it varied by projection series. In the population projections released in 1996, the U.S. Census Bureau assumed a slight increase in overall fertility, but the assumption varied by ethnic groups. For example, levels of fertility were assumed to slightly increase for Whites and Blacks while slightly decrease for Asians and remain constant for Hispanics. If we adopt the Census Bureau's assumption, we may have to consider an assumption somewhere between slight decrease in fertility and constant fertility since Hawaii has large proportion of Asian population. The Census Bureau, however, held fertility rates constant throughout the projection periods in its 2005 population projections series for states, while the previous assumptions were kept for national population projections.[3] This inconsistency may reflect lack of consensus on the assumption of increasing fertility rates in the U.S.

Total fertility rate (TFR) is a summary statistic of fertility rates which is most commonly used to examine the historical trend or inter-regional comparison of fertility rates. The TFR estimates the number of births the average woman in the population is likely to have in her lifetime. With no time series of TFR for Hawaii, TFR for the other civilian population of Hawaii was calculated using birth data for the recent 5 years described above. The result showed a slight increase in the statewide total fertility rates from 1.95 in 2001 to 2.05 in 2006.[4] It contradicts the underlying assumption in the population projection by the U.S. Census Bureau. Besides, the increasing pattern in the TFR was not shared by all counties. While Honolulu and Maui counties showed a rise in the total fertility rate, the patterns for other two counties were not clear.

With insufficient evidence and lack of detailed analysis on the direction of fertility changes in Hawaii, this projection assumed fertility rates for each county to remain constant at 2004-2006 average levels throughout the projection period.

Life Tables and Survival Rates

The life tables for the other civilian population were developed for the four counties using the same life table methodology as used for the U.S. national life tables.[5] First, mortality rates for the year 2005 were calculated by dividing the average deaths for 2004 through 2006 by the other civilian population in each category for the corresponding years. Next, the number of persons living at the beginning of each age interval was calculated. This statistic was standardized by beginning from a group total of 100,000 in the less-than-one age group. Then the number of expected deaths in each age group was

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[3] *Methodology Summary, Interim Population Projections for States by Age and Sex: 2004 to 2030*, Population Projections Branch, Population Division, U.S. Census Bureau,
Methodology and Assumptions for the Population Projections of the United states: 1999 to 2100, Population Division Working Paper N0.38, Population Division, U.S. Census Bureau, January 2000.

[4] TFRs for the resident population were calculated higher than those of the other civilian population.

[5] "United States Life Tables, 2003", *National Vital Statistics Reports*, Center for Disease Control and Prevention, April 2006.
Palmore, J. and R.Gardner, *Measuring Mortality, Fertility, and Natural Increase*, East-West Center, Honolulu, 1994.

subtracted from the number living at the beginning of that age interval to produce the number living at the beginning of the next interval. In order to approximate mid-year (July 1st) conditions, the stationary population in the interval was calculated by subtracting half the number dying in each age interval from the number living at the beginning of the interval. Survival rates for 2005 were then estimated by dividing the stationary population in each interval by the population in the previous interval (Appendix Tables A-27 through A-36).

Compared to fertility rates, future direction of changes in mortality rates is less controversial. With better health services and increased affluence, mortality rates have generally decreased over time and will continue to decrease (Figures 2-1 and 2-2).

Figure 2-1. Survival Rates for Males in Hawaii

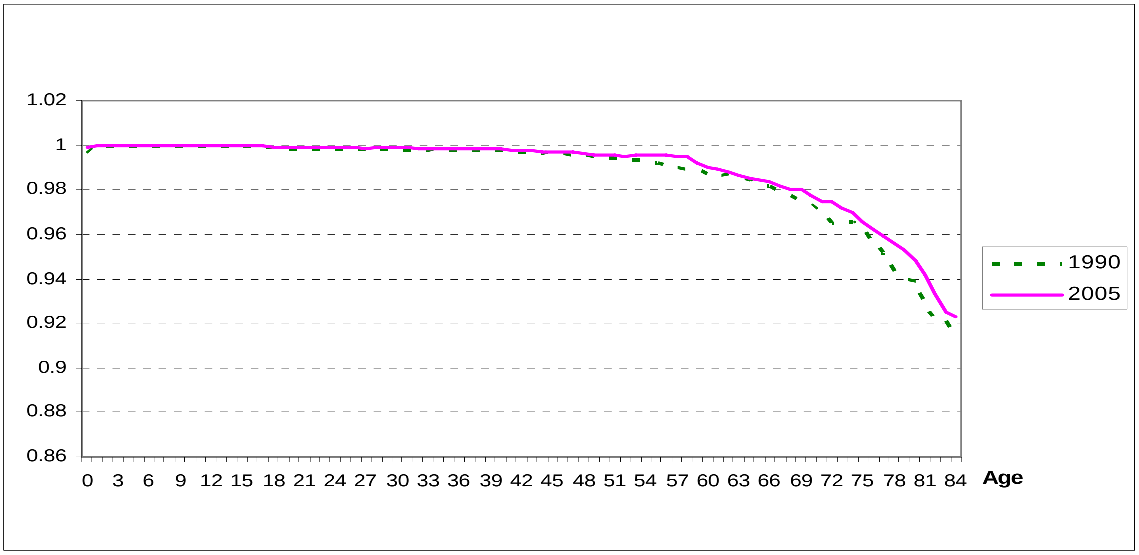
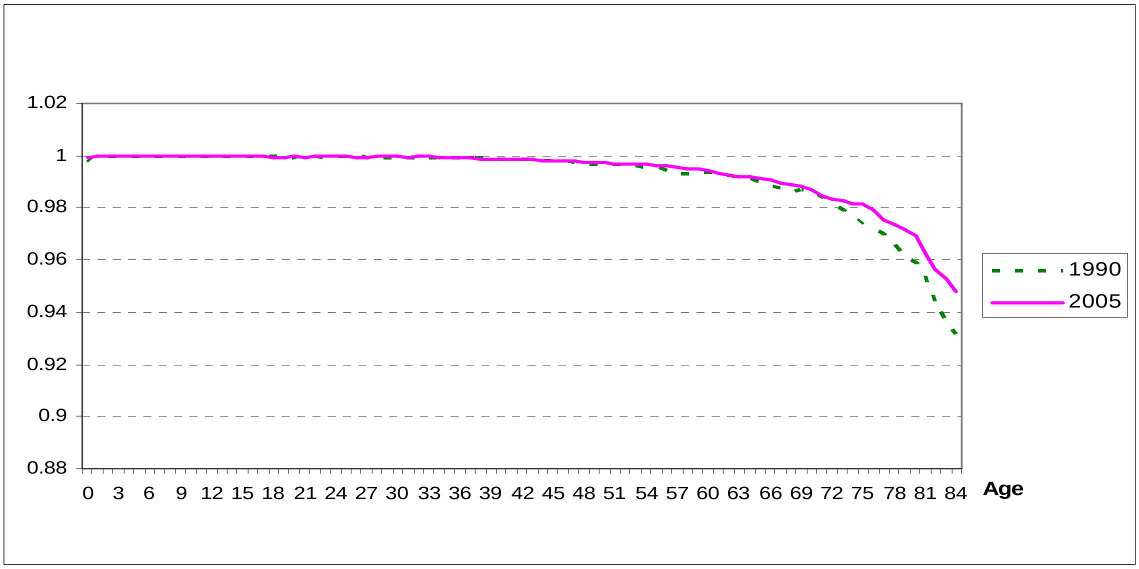


Figure 2-2. Survival Rates for Females in Hawaii



The question was to what degree and in what pattern the mortality rates would decrease in the future. Using methodologies used by the U.S. Census Bureau, age- and sex-specific mortality rates were adjusted in the following manner. First, target life expectancies at birth for the four counties in Hawaii were developed using target life expectancy for the nation developed by the Census Bureau as a reference. The middle series projections of the Census Bureau, that were published in January 2000, were based on the assumption that average life expectancy at birth for the U.S. will increase gradually from 1999 values of 74.1 years for the male population and 79.8 years for the female population to 2050 values of 81.2 years for the male population and 86.7 years for the female population.[6] Based on a review of historical relationship between life expectancy in Hawaii and that of the U.S., target life expectancies for the four counties in Hawaii in 2035 were developed as presented in Table 2-2.

Table 2-1. Life Expectancy at Birth for the U.S. and Hawaii: 1980-2005
(Total Resident Population)

	United States			**Hawaii**		
	Both Sexes	Male	Female	Both Sexes	Male	Female
1980	73.7	70.0	77.4	77.8	74.5	81.5
1990	75.4	71.8	78.8	78.9	75.9	82.1
2000	77.0	74.3	79.7	79.8	77.1	82.5
2001	77.2	74.4	79.8	80.1	77.4	82.9
2002	77.3	74.5	79.9	80.0	77.3	82.8
2003	77.5	74.8	80.1	80.1	77.1	83.1
2004	77.8	75.2	80.4	80.4	77.4	83.4
2005	N/A	N/A	N/A	80.5	77.6	83.4
2006	N/A	N/A	N/A	80.4	77.6	83.2

Source: Hawaii State Data Book, multiple issues.
Life expectancies for Hawaii for 2001- 2006 are estimates by the DBEDT.

Table 2-2. Projected Life Expectancy at Birth for Hawaii: 2005 and 2035
(Other Civilian Population)

	Life Expectancy in 2005[1/]		**Projected Life Expectancy in 2035**[2/]	
	Female	Male	Female	Male
State of Hawaii	83.3	78.2	87.2	82.3
Hawaii County	82.2	77.2	86.2	81.4
Honolulu County	83.5	78.2	87.4	82.3
Kauai County	83.3	78.1	87.2	82.2
Maui County	82.8	78.4	86.8	82.5

1/ DBEDT Estimates.
2/ DBEDT Projections.

The next step involves adjusting mortality rates to meet the target life expectancies. To develop the pattern of mortality decline in the future, the Census Bureau collected expert

[6] *Methodology and Assumptions for the Population Projections of the United states: 1999 to 2100*, Population Division Working Paper N0.38, Population Division, U.S. Census Bureau, January 2000.

opinions regarding how much faster the mortality rates of some age groups will decline in the future relative to the others. They divided population into three age groups: age group under 15, age group between 15 and 65, and age group over 65. Their survey is summarized that "average annual rate of mortality decline" experienced by the age group under 15 years will be 2.1 times higher than that of the age group over 65 years until 2020 and 1.6 times higher for the year after 2020. For the age group between 15 to 64 years, it will be 1.3 times higher than that of the age group over 65 years until 2020 and 1.2 times higher for the year after 2020. [7]

In this projection, same rates of mortality decline as developed by the Census Bureau were assumed with one modification. The age group over 65 years was further divided into two groups: age group between 65 and 84 and age group over 85. This modification was introduced with the notion that mortality rates for extremely high ages tended to be underestimated in Hawaii. Underestimation of mortality and overestimation of population at extremely high ages have been reported by many demographers.[8] In order to reduce this potential exaggeration of older population, it was assumed that mortality rates of age group over 85 years will decrease at a rate lower than that of the age group between 65 to 84 years throughout the projection period.

Using these assumptions, life tables for the projection period were constructed to project population and deaths of other civilian for each county in each year.

Net Migration

Net migration includes net domestic migration and net international migration. This projection used separate assumptions for two types of migration because they are believed to be determined by different set of factors.

A time series of net international migration was constructed based on the estimates of the U.S. Census Bureau. The data on net domestic migration are either not available or not reliable. For this reason, net domestic migration was estimated by subtracting the sum of natural increase and net international migration from total civilian population change.

For the period from 1970 to 2005, Hawaii net international migration averaged 6,800-6,900 people per year, exhibiting a relatively stable pattern over time. Since international migration to the U.S. is by-and-large affected by the U.S. immigration policy, it was assumed that net international migration will remain constant over the projection period at 5,340 per year, which is the average of net international migration for the recent 5 years.

Domestic migration is strongly influenced by economic conditions in Hawaii, especially, difference in economic conditions between Hawaii and the Mainland U.S. In current projections, domestic net migration (DNETMIG) was modeled to depend on the

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[7] See same reference as in the footnote 3, pp12-13.

[8] Wilmoth, J.R., "Are Mortality Rates Falling at Extremely High Ages: An Investigation Based on a Model Proposed by Coale and Kisker", *Population Studies,* Vol.49. No.2, July 1995, pp281-295.

statewide unemployment rate projected from the economic module. Due to the extreme volatility shown in the past, the model could not be estimated with some acceptable accuracy. Therefore the original estimation results were adjusted such that the estimate of statewide annual net domestic migration fell in a range from 1,000 to 4,600 depending on the statewide unemployment rate.

$$DNETMIG_{t,state} = \beta_0 + \beta_1 \bullet UNEMPRT_{t,state}$$

The projected net migration for the state total was allocated to each county using the patterns observed in the past 5 years, and each county total was then allocated to each single age-sex category using its distributions in the Census 2000 migration data and in the 2005 American Community Survey (ACS) migration data.

6. Tourism Projections

The tourism projections underlying the DBEDT 2035 Series reflect a combination of econometric analyses and relationship modeling.

Visitor Arrival Projections

Visitor arrivals in Hawaii have gone through several different growth periods. Between 1960 and 1973, arrivals grew at a double-digit annual rate of 18.3 percent. Between 1973 and 1990, arrivals growth slowed down to an annual growth rate of 5.7 percent. During 1990 and 2003, visitor industry experienced stagnation with arrivals declining at 0.4 percent annually. During 2004-2005, Hawaii visitor industry experienced a growth again at the 7-8 percent range, but the growth did not last long. Visitor arrivals in 2007 declined again. Given the maturity of Hawaii’s tourism industry, the supply constraints in the state, and the increasing competition from other international destinations, Hawaii visitor arrival is expected to grow at a slower rate in the future.

High Growth Scenario

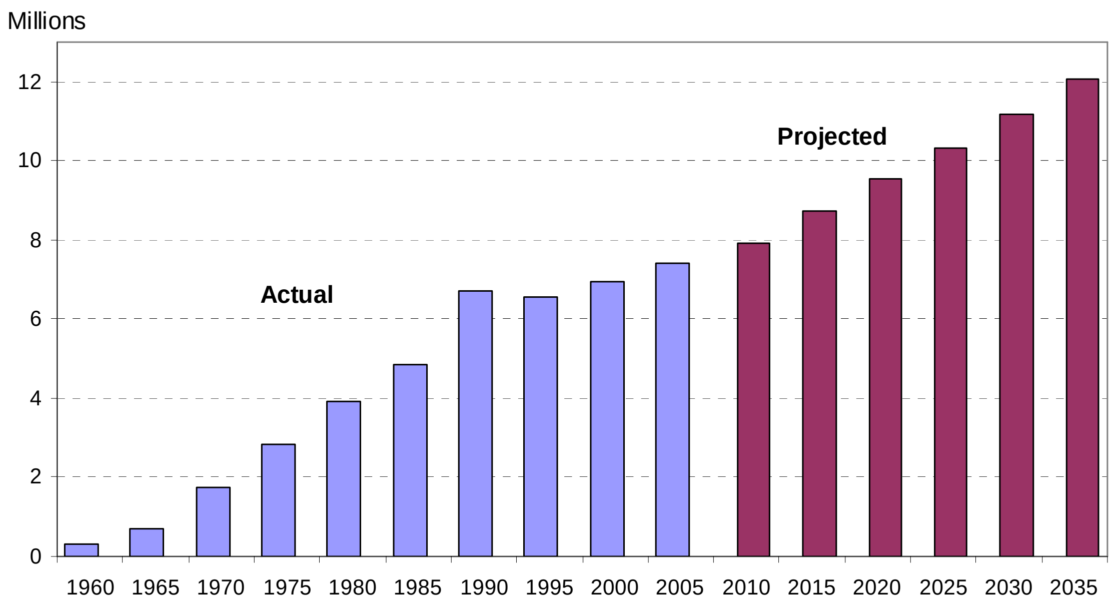
Under this scenario, visitor growth is expected to follow the 1973 to 2006 trend after filtering out the high growth period of 1987-1991 and the terrorist attack/SARS/Iraqi War impact period of 2001-2003. Visitor arrival (VA) was projected using the following econometric model:

$$VA_{t,\ state} = \beta_0 + \beta_1 \bullet Time + \beta_2 \bullet DUM8791 + \beta_3 \bullet DUM0103 + \beta_4 \bullet DUMD0535$$

where Time = time trend
DUM8791 = dummy variable representing the period of 1987-1991
DUM0103 = dummy variable representing the period of 2001-2003
DUM0535 = dummy variable representing the period from 2005 to 2035
Period estimated: 1972-2005

Under the high growth scenario, annual visitor arrival growth rate is expected to be about 1.5 percent between 2005 and 2035. Visitor arrival projections under the high growth scenario are depicted in Figure 2-3.

Figure 2-3. Visitor Arrival Projection: High Growth Scenario



Low Growth Scenario

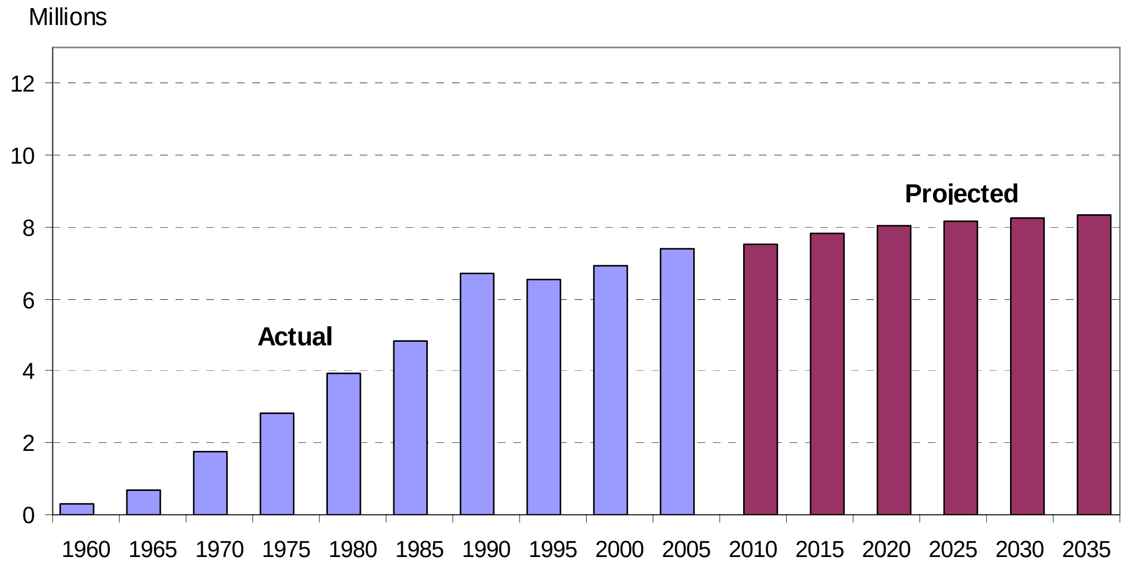
Under this scenario, visitor arrival is expected to grow at the trend experienced after 1990. During this period, 7 out of 17 years had negative arrival growth. Natural disaster and external events contributed to the negative growth including the 1992 Hurricane Iniki and the 2001 Terrorist attack, Iraqi War and SARS in 2003. These natural and external events were filtered out when projecting the future arrivals using the following econometric model:

$$VA_{t,\ state} = \beta_0 + \beta_1 \bullet Time + \beta_2 \bullet DUM93 + \beta_3 \bullet DUM9091 + \beta_4 \bullet DUMD0103 + \beta_5 \bullet DUMD0535$$

where Time = time trend
D92 = dummy variable representing the year of 1993
D9091 = dummy variable representing the period of 1990-1991
D0103 = dummy variable representing the period of 2001-2003
D0535 = dummy variable representing the period from 2005 to 2035
Period estimated: 1990-2005

Under the low growth scenario, visitor arrival was projected to grow at an annual rate of 0.4 percent over the projection period. Visitor arrival projections under the low growth scenarios are shown in Figure 2-4.

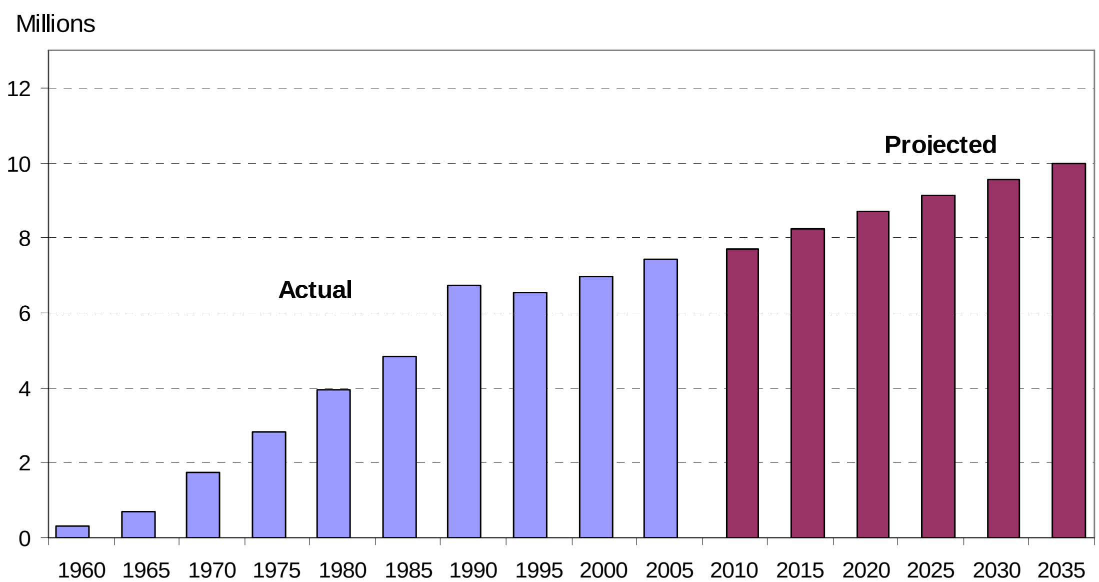
Figure 2-4. Visitor Arrival Projection: Low Growth Scenario



Average Growth Scenario --baseline scenario

The baseline scenario for the 2035 projection series was developed by averaging the growth of high growth and the low growth scenarios, resulting in an annual average growth of 1.0 percent for the 2005 and 2035 period. These results are displayed in Figure 2-5.

Figure 2-5. Visitor Arrival Projection: Average Growth (Baseline) Scenario



Visitor Days and Daily Visitor Census

Visitor days and daily census were projected using the following steps and assumptions.

1. Growth of total visitor arrivals: projected using econometric models
2. Domestic and international arrivals = total arrivals × share of domestic and international visitors; shares were developed based on historical trends
3. Visitor days = arrivals × average length of stay; average length of stay were developed based on historical trends
4. Statewide average daily visitor census = visitor days/365
5. Daily visitor census by county = Statewide average daily visitor census × county share of daily visitor census, county shares of daily visitor census were developed based on historical trends
6. Arrivals by county = daily visitor census × 365 / average length of stay by county; average length of stay by county was developed based on historical trends

Table 2-3 presents the assumptions used in projecting visitor days, daily census, and the arrivals by county.

Table 2-3. Assumptions for the Projections of Visitor Days and Daily Visitor Census

Variable	1970 - 2000[1/]	2005[1/]	2010	2015	2020	2025	2030	2035
Domestic visitor share (%)	63.6	71.6	73.0	72.5	72.0	71.5	71.0	70.5
International visitor share (%)	36.4	28.4	27.0	27.5	28.0	28.5	29.0	29.5
Domestic visitor length of stay (days)	10.2	9.9	9.9	9.9	9.9	9.9	9.8	9.8
International visitor length of stay (days)	6.5	7.1	7.1	7.1	7.1	7.1	7.1	7.0
Honolulu share of daily census (%)	55.0	48.3	48.1	47.9	47.7	47.5	47.3	47.1
Maui share of daily census (%)	24.0	26.1	26.3	26.4	26.5	26.6	26.6	26.6
Kauai share of daily census (%)	9.4	10.6	10.7	10.7	10.8	10.8	10.9	10.9
Hawaii share of daily census (%)	11.6	15.0	14.9	15.0	15.0	15.1	15.2	15.4
Honolulu visitor length of stay (days)	7.0	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Maui visitor length of stay (days)	7.0	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Kauai visitor length of stay (days)	6.3	6.6	6.5	6.5	6.5	6.5	6.5	6.5
Hawaii visitor length of stay (days)	6.5	6.6	6.5	6.5	6.5	6.5	6.5	6.5

1/ Actual figures, Source: DBEDT.

Visitor Expenditures

Visitor expenditures were projected using the following procedures and assumptions:

1. Air visitor per person per day spending (PPPD) = PPPD in 2006 × $(1+\text{PPPD growth factor}/100)^t$; expenditure growth factor was developed based on Hawaii inflation rate, where t was number of years in the interval
2. Air visitor personal expenditures = visitor days × PPPD
3. Supplemental business expenditures = supplemental business expenditures in 2006 ×$(1+\text{business expenditure growth factor}/100)^t$; business expenditure growth factor was developed based on past trend, and t was number of years in the interval.
4. Cruise visitor expenditures = Cruise visitor expenditure in 2006 ×$(1+\text{cruise visitor expenditure growth factor}/100)^t$; cruise visitor expenditure growth factor was developed based on past trend, and t was number of years in the interval.
5. Total visitor expenditures = Air visitor expenditures + supplemental business expenditures + cruise visitor expenditures.
6. Visitor expenditures by county = Total visitor expenditures × county share of visitor expenditures; county expenditure shares were developed based on past trends and the projected share of visitor days.

Table 2-4 presents the assumptions for projecting visitor expenditures.

Visitor Room Demand

Demand for visitor rooms was projected using the following procedure and assumptions:

1. Occupied visitor units = Daily visitor census / Ratio of daily visitor census-to-occupied visitor rooms; the ratios were developed based on historical trends.
2. Visitor unit demand = Occupied visitor units / hotel occupancy rate ceiling; hotel occupancy rates ceiling is the occupancy rate that above which new hotels are needed. The occupancy ceilings were assumptions based on past occupancy trends.

Table 2-5 shows the assumption used in calculating visitor unit demand.

Summary of projected key tourism variables under alternative scenarios are presented in Appendix Tables A-64 through A-66.

Table 2-4. Assumptions for the Projections of the Visitor Expenditures

Variable	2005[1/]	2010	2015	2020	2025	2030	2035
Air visitor PPPD growth factor, annual (%)		3.0	3.0	3.0	2.9	2.7	2.5
Supplemental business expenditure growth factor, High Growth Scenario, annual (%)		1.5	1.5	1.5	1.5	1.5	1.5
Supplemental business expenditure growth factor, Average Growth Scenario, annual (%)		1.0	1.0	1.0	1.0	1.0	1.0
Supplemental business expenditure growth factor, Low Growth Scenario, annual (%)		0.5	0.5	0.5	0.5	0.5	0.5
Cruise visitor expenditure growth factor, High Growth Scenario, annual (%)		2.0	2.0	2.0	2.0	2.0	2.0
Cruise visitor expenditure growth factor, Average Growth Scenario, annual (%)		1.5	1.5	1.5	1.5	1.5	1.5
Cruise visitor expenditure growth factor, Low Growth Scenario, annual (%)		1.0	1.0	1.0	1.0	1.0	1.0
Honolulu share of total visitor expenditures (%)	48.5	46.2	45.8	45.4	45.0	44.6	44.2
Maui share of visitor expenditure (%)	27.8	29.9	30.1	30.3	30.5	30.7	30.9
Kauai share of visitor expenditures (%)	9.8	10.4	10.4	10.4	10.4	10.4	10.4
Hawaii share of visitor expenditures (%)	14.0	13.4	13.6	13.8	14.0	14.2	14.4

1/ Actual figures, Source: DBEDT.

Expert Opinion

One method of checking the reasonableness of an analytical forecast is to compare it with the opinion of experts on the subject matter. In late 2007, using a Delphi technique DBEDT commissioned a survey of experts in the various tourism markets. The results suggest that visitor arrivals will likely be 8.1 million by 2035, representing 0.32 percent annual growth. This is close to the low growth scenario used in this projection.

Table 2-5. Assumptions for the Projections of Visitor Room Demand

Variable	1970 - 2000[1/]	2005[1/]	2010	2015	2020	2025	2030	2035
Honolulu: Ratio of daily visitor census and occupied visitor rooms, (persons/room)	2.7	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Maui: Ratio of daily visitor census and occupied visitor rooms, (persons/room)	3.0	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Kauai: Ratio of daily visitor census and occupied visitor rooms, (persons/room)	3.3	3.6	3.6	3.6	3.6	3.6	3.6	3.6
Hawaii: Ratio of daily visitor census and occupied visitor rooms, (persons/room)	3.0	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Honolulu: Hotel occupancy rate ceiling (%)	77.1	85.6	83.4	83.9	83.9	83.9	83.9	83.9
Maui: Hotel occupancy rate ceiling (%)	70.2	79.6	82.3	82.9	82.9	82.9	82.9	82.9
Kauai: Hotel occupancy rate ceiling (%)	65.6	76.7	78.8	81.8	81.8	82.9	82.9	82.9
Hawaii: Hotel occupancy rate ceiling (%)	61.5	72.2	68.7	70.7	70.7	70.7	70.7	70.7

1/ Actual figures, Source: DBEDT.